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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
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EXAMINER	
BEHNCKE, CHRISTINE M	

ART UNIT	PAPER NUMBER
3661	

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Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Office Action Summary	Application No.	Applicant(s)
	10/811,460	ESTKOWSKI ET AL.
	Examiner	**Art Unit**
	Christine M. Behncke	3661

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *05 October 2007*.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1-26* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☒ Claim(s) *12* is/are allowed.

6)☒ Claim(s) *1-11 and 13-26* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☒ The drawing(s) filed on *26 March 2004* is/are: a)☒ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

KHOI H. TRAN
SUPERVISORY PATENT EXAMINER

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO/SB/08) Paper No(s)/Mail Date _____.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .
5) ☐ Notice of Informal Patent Application
6) ☒ Other: *NonPatent literature (2)*.

DETAILED ACTION

This office action is in response to the Amendment and Remarks filed 5 October 2007, in which claims 1-26 were presented for examination.

Response to Arguments

Applicant's arguments with respect to claims 1-26 have been considered but are moot in view of the new ground(s) of rejection.

Claim Rejections - 35 USC § 103

The text of those sections of Title 35, U.S. Code not included in this action can be found in a prior Office action.

Claims 1-11, 13, 14, 16-18, 20, 22 and 23 rejected under 35 U.S.C. 103(a) as being unpatentable over Urmson et al., "Approaches for Heuristically Biasing RRT Growth", IEEE, October 2003, pages 1178-1183, in view of Kindel et al., "Kinodynamic Motion Planning Amidst Moving Obstacles", IEEE, April 2002, pages 537-543.

(Claim 1) Urmson describes a method of planning at least one path for an object in a state space from a starting position to a goal position to avoid a plurality of static and/or dynamic objects, comprising: associating predetermined attributes with the plurality of static objects and/or the plurality of dynamic objects located in the state space, the state space being a probability space (section 2, lines 1-19); generating a probabilistic tree in the state space including a plurality of branches extending from the starting position of the vehicle towards the goal position located in the state space (section 2, lines 1-19); extending the plurality of branches of the probabilistic tree towards the goal position located in the state space based on a plurality of random tree

extension rules and a plurality of deterministic tree extension rules until satisfying a predetermined stopping condition (section 3 and section 5, lines 47-61). Urmson does not state that the branches are evaluated for satisfying predetermined trajectory path constraints. However, Kindel et al. teaches a kinodynamic motion planning method including using random and deterministic rules to expand the tree branches and further evaluating at least a first branch of the plurality of branches of the probabilistic tree for determining whether the first branch of the plurality of branches of the probabilistic tree satisfies predetermined trajectory path constraints (section 1, lines 22-37 and section 4, lines 1-33). It would have been obvious to one of ordinary skill in the robotic art to include the predetermined trajectory path constraints in determining the path of the mobile robot, because as Kindel et al. suggests, some robots operate under severe dynamic constrains, having limited actuator forces and torques, and if the trajectory path constraints are not taken into account there is little practical application for moving the robot amongst moving obstacles.

(Claim 2) Urmson further suggests declaring the first branch of the plurality of branches of the probabilistic tree as the at least one preferred trajectory path for the vehicle in the state space (section 3, figure 6); and controlling the vehicle to follow the at least one preferred trajectory path in the state space for moving the vehicle from the starting position towards the goal position in the state space (figure 6).

(Claims 3, 4, 5 and 6) Kindel further suggests extending the plurality of branches of the probabilistic tree further based on the at least one of the plurality of random tree extension rules and the plurality of deterministic tree extension rules until at least one

branch of the plurality of branches of the probabilistic tree satisfies the predetermined stopping condition (section 2, lines 20-32) and declaring the at least one branch of the plurality of branches of the probabilistic tree that couples the starting position to the goal position as the at least one preferred trajectory path for the vehicle in the state space (figure 6 and section 4.1). Kindel further teaches repeating one or more previous steps at predetermined time intervals as the vehicle moves along the at least one preferred trajectory path toward the goal for updating the at least one preferred trajectory path to compensate for motion of the plurality of dynamic objects (section 1, lines 68-82). Kindel further teaches satisfying the predetermined stopping condition includes at least one of satisfying a predetermined time constraint and satisfying a predetermined travel distance constraint (section 1, lines 68-82). While Urmson does not describe the path conforming to trajectory path constraints, as suggested by Kindel it would have been obvious to one of ordinary skill in the robotic art to require the final path to conform to the predetermined trajectory path constraints in order to practically allow the mobile robot to traverse the obstacle course. Kindel suggests it would have been obvious to one of ordinary skill in the robotic art to include predetermined condition as a stopping condition and updating the path periodically for moving obstacles, as these are well known steps of using a probabilistic-roadmap technique.

(Claim 7) Urmson further describes wherein associating predetermined attributes with the plurality of objects located in the state space includes associating at least one of a position value, a velocity value, a direction value, an acceleration value and a time value (section 4.4).

(Claims 8-10) Urmson describes the building of the probabilistic tree, but does not specify that the branches are extended with a predetermined distance and direction. However, Kindel teaches that with a robot in severe constraint limitations, generating the tree includes extending each of a first plurality of edges a first predetermined distance and direction from the starting position in the state space to each of a corresponding first plurality of nodes based on the plurality of random tree extension rules and the plurality of deterministic tree extension rules for forming first segments of each of the plurality of branches of the probabilistic tree (section 2, lines 53-69 and lines 114-138). Kindel further teaches extending at least one of a next successive plurality of edges from each of the first plurality of nodes a second predetermined distance and direction in the state space to each of a corresponding next successive plurality of nodes based on the plurality of random tree extension rules and the plurality of deterministic tree extension rules for forming next successive segments of each branch of the plurality of branches of the probabilistic tree (section 2, lines 53-83 and lines 133-138). Kindel further teaches repeating cyclically extension of each branch of the plurality of branches of the probabilistic tree until at least the first branch of the plurality of branches of the probabilistic tree satisfies the stopping condition (section 2, lines 106-113). Kindel further teaches repeating cyclically extension of each branch of the plurality of branches of the probabilistic tree until at least the first branch of the plurality of branches of the probabilistic tree satisfies the stopping condition (section 1, lines 68-82). It would have been obvious to one of ordinary skill in the robotic art at the time of the invention to combine the teachings of Kindel with the method of Urmson because as

Kindel suggests the predetermined distance and direction is determined by the robot kinodynamic constraints and then naturally enforced with the search of the tree branches, thereby making sure the path planning does not become out of step with the limitations of the robot (section 2, lines 53-69).

(Claim 11) Urmson further describes evaluating whether extension of one or more branches of the plurality of branches of the tree violate object avoidance constraints (section 4.2); and suspending further extension of the one or more branches of the plurality of branches if a determination is made that extension of the one or more branches of the plurality of branches of the tree violate the object avoidance constraints (figure 6, sections 4.1 and 4.2).

(Claim 13) Urmson further describes extending the plurality of branches of the probabilistic tree based on the plurality of random tree extension rules includes at least one of extending each branch into the state space that is void of the plurality of static objects and the plurality of dynamic objects and extending each branch into the state space that is void of other branches of the plurality of branches of the probabilistic tree (figure 8, section 4.3).

(Claim 14) Urmson further describes extending the plurality of branches of the probabilistic tree based on the plurality of deterministic tree extension rules includes at least one of extending each branch towards the goal and extending each branch in a straight line with respect to a previous extension of each branch (section 2, lines 20-32).

(Claim 16) Urmson describes a path planning method for a vehicle, comprising:

defining a state space including an initial start position and a goal position, the state space being a probability space (section 2, lines 13-32); generating a plurality of paths from the start position to the goal position over time on a node by node basis based upon a set of rules comprising including at least one of a deterministic rule, a randomness rule, and a probabilistic rule (section 3, lines 9-16, lines 1-8, and 17-37); assigning locations to objects in the state space over time based upon respective probability distributions (section 3, lines 2-5); and selecting a first one of the generated plurality of paths (figure 6). Kindel further explains the method of using the RRT decision to determine the path to the goal.

(Claim 17) Urmson further describes terminating ones of the plurality of paths that are not feasible at a given node in the state space (figure 6 and section 4.1).

(Claim 18) Urmson further describes terminating paths based upon one or more of impact with an object, region avoidance, g-force limitations, sensor information, path distance, path time, number of turns, altitude change limitations, straight path desirability, object location confidence level, turning radius limitations, and turning penalties (section 1, lines 1-12, figure 6).

(Claim 20) Urmson further describes assigning object state information including one or more of position, heading, velocity, acceleration, turning radius, acceleration limit, velocity limit, g-force limit, and location confidence level (section 4.4).

(Claim 22) Urmson describes a method of adaptive path planning for a vehicle, comprising: defining a state space for the vehicle and a plurality of objects, the state space being a probability space (section 1); setting a root node to initial state for the

vehicle (section 1, x_{int}); generating a plurality of paths comprising node-to-node branches from a vehicle start location to a goal location, each node being a probability distribution (figures 1 and 2, section 3, lines 17-37); examining each of the branches to determine whether stopping conditions are satisfied (section 4.1); generating first ones of the branches using deterministic rules (section 5, lines 47-61); generating second ones of the branches using random extension rules (section 5, lines 47-61); determining whether first ones of the plurality of branches should terminated (section 3, lines 9-37); and selecting a first one of the plurality of paths that extend to the goal location (section 3, lines 9-37, figure 6). Kindel further explains the method of using the RRT decision to determine the path to the goal.

(Claim 23) Urmson further describes assigning state information to the plurality of objects including one or more of position, heading, velocity, acceleration, turning radius, acceleration limit, velocity limit, g-force limit, and location confidence level (section 4.4).

Claim Rejections - 35 USC § 103

Claim 15 is rejected under 35 U.S.C. 103(a) as being unpatentable over Urmson in view of Kindel, in further view of Hsu et al. "Randomized Kinodynamic Motion Planning with Moving Obstacles", March 2002, pages 1-36, Database Inspection on-line, The Institute of Electrical Engineers.

Urmson in view of Kindel teach the application of predetermined trajectory path constraints but do not specify that the branches satisfy at least one of a maximum travel distance value, a maximum turn angle value, a minimum distance value to the plurality of static objects and the plurality of dynamic objects. However, Hsu teaches the motion

planning of a robot around static and dynamic objects using a PRM planner, further including determining whether the first branch of the plurality of branches of the probabilistic tree satisfies the predetermined trajectory path constraints includes determining whether the first branch of the plurality of branches of the probabilistic tree satisfies at least one of a maximum travel distance value, a maximum turn angle value, a minimum distance value to the plurality of static objects and the plurality of dynamic objects (section 3.1). It would have been obvious to one of ordinary skill in the art at the time of the invention to combine the method of Urmson in view of Kindel with the teachings of Hsu, because as Hsu suggests the branches must be compliant with vehicle/robot dynamic constraints in order to accurately plan the state space and trajectory of the path the vehicle is capable of traversing (section 3.1).

Claim Rejections - 35 USC § 103

Claims 19 and 21 are rejected under 35 U.S.C. 103(a) as being unpatentable over Urmson in view of Kindel et al. as applied to claim 16 above, and further in view of LaValle et al., "Randomized Kinodynamic Planning", May 10 1999, pages 473-479, Volume 1, Detroit Michigan.

Neither Urmson nor Kindel teach using a confidence level of object locations or assigning a probability distribution to the object station information. However, LaValle et al. teaches a path planning system wherein the system assigns a confidence level to object locations and a probability distribution to one or more components of the objects (column 4, lines 13-34). It would have been obvious to one of ordinary skill in the art to combine the method of Urmson in view of Kindel with the teachings of LaValle et al.

because assigning a probability to the component of an object and a confidence level to the object location allows the robot to move possibly closer to the object, and increases the range of possible trajectories towards the goal.

Claim Rejections - 35 USC § 103

Claims 24-26 are rejected under 35 U.S.C. 103(a) as being unpatentable over Urmson et al.

(Claims 24 and 26) Urmson describes a system to plan a path for a vehicle, comprising: defining a state space for the vehicle and a plurality of objects, the state space being a probability space (section 1); setting a root node to initial state for the vehicle (section 1, x_{int}); generating a plurality of paths comprising node-to-node branches from a vehicle start location to a goal location, each node being a probability distribution (figures 1 and 2, section 3, lines 17-37); examining each of the branches to determine whether stopping conditions are satisfied (section 4.1); generating first ones of the branches using deterministic rules (section 5, lines 47-61); generating second ones of the branches using random extension rules (section 5, lines 47-61); determining whether first ones of the plurality of branches should terminated (section 3, lines 9-37); and selecting a first one of the plurality of paths that extend to the goal location (section 3, lines 9-37, figure 6).

(Claim 25) Urmson further describes providing instruction to provide state information to the plurality of objects including one or more of position, heading, velocity, acceleration, turning radius, acceleration limit, velocity limit, g-force limit, and location confidence level (section 4.4).

Urmson does not describe first formulating the path plan on a workstation then downloading the selected path to a vehicle, however this would have been obvious to one of ordinary skill in the robotic art if the selected robot does not have the required processing power or if time/expense of the robot must be restricted.

Allowable Subject Matter

Claim 12 is allowed.

Conclusion

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Christine M. Behncke whose telephone number is (571) 272-8103. The examiner can normally be reached on 8:30 am- 5pm.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Thomas G. Black can be reached on (571) 272-6956. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

CMB

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SUPERVISORY PATENT EXAMINER